

## 6020T Laser Tube Cutting

### Machine

# Maintenance Guide

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## Preface

Thank you for purchasing products from Jinan Senfeng Laser Technology Co., Ltd.

We are committed to providing you with excellent service.

This high-tech product, developed and manufactured by our company, integrates optics, machinery, and electronics. It offers a compact design, high precision, durability, and cost-effectiveness. For optimal maintenance and use, please read this manual and its attachments before operating the fiber laser tube cutting machine.

Please understand the machine's principles, structure, performance, and maintenance. Follow proper maintenance procedures and safety practices to handle emergencies effectively and prevent accidents.

If you have any questions, contact us immediately. Do not use the machine until the issue is resolved.

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# 1 Safety

Neglecting safety precautions during operation, inspection, or maintenance can cause equipment failures. Therefore, read and understand the safety measures in this manual before use. Do not operate the equipment otherwise to avoid harm and damage.

Safety precautions in this manual are categorized as follows:

 Danger	The "Danger" label indicates that failure could result in severe injury or death.
 Warning	The "Warning" label indicates that failure could potentially cause moderate injury or death.
 Caution	The "Caution" label indicates that failure could result in minor injury or performance damage.
 Attention	The "Attention" label indicates that a failure may result in performance degradation or a shortened lifespan of the fiber laser tube cutting machine.

The terms "safe," "safely," and "safety" used in this manual do not imply an absence of risk at all times. Due to varying operating conditions, methods, and environments, any procedure could be considered "unsafe." Therefore, the methods and procedures in this manual should be regarded as general guidelines and may need to be adjusted based on

specific circumstances.

## 1.1 Laser Product Safety Classification

Laser products are classified into four categories based on safety and power, according to the Accessible Emission Limits (AEL) table (see GB7247-2001), summarized as follows:

Class 1: The laser product is inherently safe and will not exceed the maximum permissible exposure under any conditions.

Class 2: The laser emits visible light, typically protected by the natural reflex of the eye to avoid exposure.

Class 3A: The laser product is harmful when the beam is viewed directly through optical instruments.

Class 3B: Lasers that can be hazardous to the eyes if viewed directly along the beam path.

Class 4: Lasers that are hazardous to the eyes and skin from direct, specular, or diffuse reflection.

## 1.2 Hazards during Equipment Operation

### 1.2.1 Mechanical Hazards

Mechanical moving parts may pose risks of collision or crushing due to human error or component failure.

### 1.2.2 Heat Hazards

During laser cutting, high temperatures are generated, which poses a fire risk if flammable organic solvents or particles are present in the surrounding environment.

### 1.2.3 Burning Hazards

Fiber laser beams have intense thermal energy and can ignite flammable materials (such as wood, paper, or clothing). Therefore, a suitable fire extinguisher should be available around the fiber laser tube cutting machine.

Additionally, flammable materials should not be stored or left in the laser control area, and special attention should be paid to fire safety when cutting materials with low ignition points.

### 1.2.4 Radiation Hazards

1. Direct, reflected, or scattered laser beams can cause serious burns to the eyes and skin.
2. Do not look directly at the red dot indicator of laser, as it may cause eye burns.

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3. Laser radiation may pose a fire or explosion hazard.

4. Risks from ionizing radiation.

## 1.3 Safe Operations

### 1.3.1 Basic Rules



Warning

Before starting, please read and understand this manual.

Ignoring these instructions may lead to serious personal

1. Do not turn on any power or switches before reading this manual. Follow the steps described in it, and do not operate any other unspecified components.

Anything not mentioned should be considered “not allowed.”

2. Identify potential hazards and take steps to avoid them.

3. Do not rely on subjective judgments to make incorrect conclusions while operating, as this can lead to dangerous accidents.

4. If you have any questions, consult your monitoring personnel or contact us.



Warning

This equipment must be operated by experienced,

safety-trained personnel and approved by supervisors.

Unauthorized use may cause serious injury!

This equipment should only be operated by personnel who have completed safety training and are authorized by monitoring staff. Unauthorized personnel are prohibited.

1. Do not operate the equipment under the influence of medication, sedatives, or

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alcohol.

2. Only qualified electrical engineers should service optical and electronic components.



Warning

The manual should be kept in a designated, easily accessible location near the fiber laser tube cutting machine.

1. Assign a specific person to manage this manual to prevent loss or damage.
2. If the manual is lost or damaged, please provide the equipment model and serial number and contact us for a paid replacement.

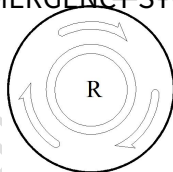


Warning

Press the EMERGENCY STOP button immediately if there is any injury or signs of an equipment malfunction.

Operators should know the button's function and location for quick access.

EMERGENCY STOP



Operators must be familiar with the EMERGENCY STOP button's location and procedure. To prevent danger in emergencies, your company should establish internal emergency response measures and steps for workers other than the operators.



Warning

Wear appropriate clothing to avoid serious personal injury while operating the fiber laser tube cutting machine.

1. Wear suitable clothing and long pants, ideally heat-resistant protective gear, to minimize skin exposure while operating the equipment.
2. Use specialized safety goggles to prevent potential harm from the fiber laser.
3. Long hair should be tied back, and a protective helmet should be worn to avoid entanglement in the machine's moving parts. Avoid wearing jewelry that could get caught in moving components (e.g., bracelets).
4. Wear safety shoes to protect your feet.

### 1.3.2 Equipment Control

#### 1.3.2.1 Appointment of Equipment Supervisors

The equipment supervisors should have knowledge and experience in mechanical, optical (especially laser beams), and electronic circuits (especially high-voltage discharges). Their main responsibilities include:

1. Develop and implement plans to prevent damage from mechanical movement and laser beams.
2. Set up and manage the equipment control area and control operation buttons.
3. Inspect, maintain, and keep service records for the equipment.
4. Conduct safety training related to the equipment.

## 1.3.2.2 Appointment of Equipment Operators

Operators should be appointed by the equipment supervisor. They must have knowledge of hazard handling, basic mechanics, lasers, and high-voltage safety, and have completed comprehensive equipment training.

## 1.3.2.3 Safety Education



Warning

Only personnel with safety training are allowed in the laser control area; unauthorized entry may result in severe injury.

Safety training should include:

1. Characteristics, dangers, and risks of laser beams, preventive measures, and relevant regulations;
2. Risks of high-voltage circuits and preventive measures for power handling.
3. Safety precautions during laser cutting and prevention of hazardous operations by others;
4. Measures for handling dangers and troubleshooting in emergency situations.

## 1.3.2.4 Healthcare Management

The workshop regulations should require regular health checks for equipment monitors and operators, as per local laws and practical needs.

## 1.3.2.5 Equipment Failure Records

Maintenance personnel should record fault details, follow specified procedures for repairs, and notify equipment monitors, who should maintain the fault records.

## 1.3.2.6 Inspection before Operation



Warning

To minimize faults and accidents, equipment monitors should inspect relevant items before operation.

## 1.4 Safety Setup

### 1.4.1 Set up Equipment Control Area



Warning

The equipment supervisor should monitor the laser control area and ensure that no one other than the laser operator enters the area.

**The equipment control area includes:**

1. The area where the equipment operator works with the laser beam.

2. The laser installation location, the point where the laser beam is emitted, and the area through which the optical path passes.
3. Areas where the laser beam may irradiate due to uncontrolled movements.
4. Areas where mechanical parts may pose a risk due to uncontrolled movements.

**When setting up the equipment control area, ensure the following:**

1. Mark the control area with yellow lines for distinction.
2. Provide a board describing the status of the area.
3. Provide a board indicating the names of the equipment monitoring personnel and operators.
4. Prepare a board with safety precautions for the cutting process.
5. Install safety guards (doors, walls, screens, barriers, etc.) to prevent unauthorized access. An interlock switch door may be installed if needed.

**Protective shields and interlock doors should be provided by the user:**

1. Prepare an appropriate fire extinguisher.
2. Install ventilation, dust collection, deodorization, and exhaust systems.



Warning

The smoke emission system should comply with local laws and regulations. Fire sources and flammable materials must not be stored or left in the laser control area.

## 1.4.2 Safety Equipment

To ensure safe use, the equipment is equipped with safety devices. Some devices may not always fully protect operators, so it's crucial to understand their limitations and initial positions. Users should also prepare additional peripheral safeguards and protective measures.

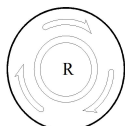
Items	Qty	Locations
EMERGENCY STOP	1	On the operation panel or electrical cabinet of the laser cutter
Main circuit breaker	1	Inside the electrical cabinet
Power key switch	1	On the laser cutter control panel
Follow protection	1	In the cutting head
Limit switches	6	On the X, Y, and Z axes of the laser cutter
Soft limit	–	In the parameter setting page of the CNC system
Alarm display	–	On the CNC system monitor
Three-color warning light	1	On the top of the control panel or the top of the separate electrical cabinet

## Functional details

### A. EMERGENCY STOP button

Pressing this button will immediately halt the operation of the equipment in an emergency stop state.

EMERGENCY STOP



### B. Main circuit breaker

This breaker automatically disconnects the power circuit to protect electrical components if the current exceeds the allowed range.

### C. Power key switch

Use this switch to turn the fiber laser cutter's power on or off. Insert and turn the key to "ON" to activate the system. Rotate to "OFF" and remove the key to disconnect power and disable the machine.



**Warning** This key should be managed by equipment monitors or authorized personnel.

### D. Follow protection

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Follow protection uses sensors to monitor the distance between the workpiece and the cutting nozzle. It quickly adjusts for any changes in distance due to variations in the workpiece's flatness, maintaining a constant distance to prevent collisions or interference.

## E. Limit switch

The limit switch prevents overtravel on each axis.

## F. Soft limit

Soft limits use system parameters to prevent overtravel on each axis.



Warning

No parameters may be modified without SENFENG's authorization.

## G. Alarm display

If the laser cutter encounters a fault, relevant information will be displayed on the CNC system screen.



Warning

If a mechanical fault triggers an alarm, maintenance should diagnose and fix the issue, then follow the specified steps to resume operation.

## H. Three-color warning light

Red: Cutter alarm

Green: Cutter operating normally

Yellow: Cutter in standby mode

## 1.5 Safety Precautions



Warning



Both the cutter and laser source carry lethal voltages and should only be operated by qualified electrical engineers.

Do not touch areas marked with warning signs, and never operate switches or keys with wet or dirty hands!

### 1.5.1 Overview

1. In case of power failure, immediately turn off the main circuit breaker.
2. Use moderate pressure when operating the control panel.
3. Keep all tools and materials clean and organized by following these guidelines:
  - 1) Place items in secure locations to prevent falling.
  - 2) Use safety measures to prevent tools or parts from falling when stored vertically.
  - 3) Ensure safety measures are in place to prevent items from toppling when stacked.

## 1.5.2 Precautions during Installation




1. Only qualified personnel may operate cranes and forklifts; others are prohibited.
2. Never position any part of your body under a crane.
3. Electrical connections must be made by qualified personnel. Ensure proper grounding to avoid electric shock. Turn off the main circuit breaker during grounding and do not close it until grounding is complete.
4. Display a warning sign during electrical connections to alert others.
5. Contact our company for equipment relocation and installation.
6. Designate a supervisor to issue instructions when multiple people are working together.
7. When wiring on the ground, use a secure and sturdy protective shield to prevent damage to the wires.
8. Use steel ropes and lifting gear at designated points to lift equipment, ensuring they can fully support the weight of the fiber laser cutter.
9. Adjust leveling according to the equipment's specified method. Do not use other methods, such as prying with steel rods.
10. Before turning on the power after equipment installation, perform the following checks:
  - 1) Ensure all electrical connections and lubrication have been completed.
  - 2) Verify that all pipelines are correctly installed and securely fastened.
  - 3) Ensure all screws and connections are tight and secure.

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- 4) Wipe off any water and dust from the equipment.
- 5) Check that there are no leaks of water or oil around the equipment.

### 1.5.3 Precautions before Operation



Warning

To prevent electrical leaks and shocks, check all cable insulation before powering on. Ensure it is intact and undamaged. Contact a qualified electrical engineer if any damage is found.

**To prevent equipment failure, the operator should check the following before starting:**

1. Ensure the work area and movable parts are free of obstacles.
2. Check for water or oil on the floor to prevent slipping.
3. Follow the steps in this manual for switching the power on/off.
4. Ensure all doors and guards are securely closed.
5. Verify the functionality of all safety devices to ensure they are not faulty or damaged.
6. After powering on, check the following:
  - 1) The display shows no error messages or alarms.
  - 2) Motors and gears make no unusual sounds.
  - 3) The electrical cabinet's cooling fan is operating normally.
  - 4) All axes and guide rails are adequately lubricated.
  - 5) Preheat the laser cutter (excluding the laser source).
7. Do not leave flammable materials or similar items in the laser control area.

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#### 1.5.4 Precautions during Operation

1. Do not damage, remove, or relocate any safety devices or interlocks.
2. During operation, adhere to the following:
  - 1) Do not open the equipment's safety covers.
  - 2) Do not enter the movable parts of the machine.
  - 3) While the equipment is running, do not perform any tasks such as tightening, measuring workpieces, removing debris, or cleaning around the equipment.
3. During external optical path adjustment, adhere to the following:
  - 1) Do not position any part of your body under the sensor mount (i.e., cutting head).
  - 2) Confirm the correct direction of movement before starting axis adjustments.
  - 3) Never direct the laser beam at any part of the body.
  - 4) Do not look directly at or touch the laser indicator light, laser beam, or scattered light to avoid serious personal injury (including blindness and burns).
  - 5) Wear the specified protective clothing and goggles during laser cutting to prevent serious injury.
  - 6) Ensure ventilation, dust collection, and exhaust systems are in place before operation to avoid severe respiratory issues.
4. If the equipment suddenly stops during operation, identify the fault and follow the prescribed steps to resume. Do not restart the equipment until this is done.
  - 1) Avoid direct hand contact with materials after cutting to prevent injuries from

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burrs or heat.

- 2) Do not wear gloves when operating switches, keys, or buttons.
- 3) Do not leave any tools or parts on the laser cutter, workbench, or surrounding areas to prevent accidental activation, worker injury, or movement of the workpiece.
- 4) Do not lean any part of your body against the laser cutter during operation to avoid accidental activation of switches or keys.
- 5) If the cutter malfunctions, shows an alarm, or shows signs of issues, promptly alert the operator and maintenance personnel.

#### 1.5.5 Precautions during Maintenance

- A. Turn off the main power before starting maintenance.
- B. Maintenance must be performed by qualified personnel. Electrical repairs, in particular, must be carried out by certified technicians.
- C. Both the laser source and control unit carry lethal voltages, which can cause serious accidents if touched. Before inspecting these units, ensure the power is off and wait for more than five minutes before opening the doors (refer to the laser source manual for specific procedures).
- D. To prevent others from turning on the main power or accidentally touching the control panel, hang a clear warning sign that reads, "**Under Maintenance—Do Not Touch!**"

- E. Do not remove or modify any limit switches or proximity switches without authorization from our company.
- F. Do not modify the control circuit to avoid malfunction or personal injury.
- G. When replacing electronic components (including bulbs, fuses, or mechanical parts), use only parts provided or specified by our company.
- H. When working at heights, use a sturdy ladder and platform, and wear a safety helmet to ensure personnel safety.
- I. If the cutter's protective cover is temporarily removed for maintenance, restore it afterward.
- J. When cleaning the cutter and surrounding equipment, stop all machine operations, turn off the power, and display a warning sign.
- K. Do not use an air gun to clean the equipment to avoid splashing cutting debris and metal shards, which could cause injury.
- L. Wear gloves when cleaning debris and metal shards.
- M. Follow the regular inspection guidelines in this manual.

## 2 Maintenance

### 2.1 Overview

Daily maintenance and upkeep are essential to ensure proper operation of the equipment. Given the high-precision components involved, extra care must be taken during maintenance, strictly following operational procedures and performed by designated personnel. Improper handling can damage components and affect machine performance. Operators and maintenance personnel must be specially trained and approved by the safety administrator before operating the equipment.

Anyone near the laser during operation should wear laser safety glasses and ensure good indoor lighting in the area.

To ensure proper use and maintenance of the equipment, familiarize yourself with the basic daily maintenance knowledge and follow the correct maintenance procedures.

### 2.2 Maintenance Cycle

The maintenance intervals for the laser source, water chiller, and air compressor should follow the guidelines in their respective manuals.

For the laser cutter, perform the first maintenance 24 hours after initial use, the next at 100 hours, and then every six months or annually (depending on customer needs).

## 2.3 Daily Maintenance

Before starting the machine daily:

Check the laser source, water chiller, and water lines for leaks.

Inspect the laser readiness button for damage (check the indicator light) and ensure the emergency stop button is functioning.

Verify that the limit switches and collision block mounting screws on the X, Y, and Z axes are secure and that the limit switches are responsive.

Check that the limit switches on the exchange table (if equipped) are responsive.

Inspect the focus lens and protective lenses for any damage.

After completing work, promptly clean up cutting debris and tidy the work area. Ensure the equipment is clean, with no stains or debris on any parts.

After daily work, open the drain valve at the bottom of the air compressor's storage tank (if using compressed air) to remove water, then close the valve once drainage is complete.

Follow the shutdown procedure to turn off the machine, then switch off the laser cutter's main power.

## 2.4 Runtime Maintenance

Before operating, perform the daily maintenance check on the laser cutter. If abnormal noises occur during operation, stop the machine immediately and inspect it.

After operation, shut down the machine in the correct sequence and clean the work

surface and surrounding area. Do not leave unrelated items on the workbench or control panel.

- A. Regularly check and top up the oil in the central lubrication pump. Adjust the oiling schedule to ensure proper lubrication of the X, Y, and Z axis guides and lead screws. This maintains accuracy and extends the lifespan of these components. If noise increases, check and add lubricant to the gear and rack as needed.
- B. Clean the air conditioner filter for dust and debris weekly.
- C. Clean the dust from the dust collector filter cartridge weekly.
- D. Check the cooling water level inside the laser source weekly and add water if needed.
- E. Check and clean the protective and focusing lenses every two weeks to ensure their lifespan.
- F. Inspect the air filters monthly and remove any accumulated water and debris.
- G. Regularly check external cables for damage and ensure connections inside the distribution cabinet are secure.
- H. After six months of installation, recheck and adjust the leveling of the fiber laser cutter to maintain cutting accuracy.

## 3 Long-term Maintenance

### 3.1 Inspection and Maintenance of Water and Gas Systems

The water system has two parts: one part circulates cooling water from the chiller to the laser source, cooling it via a heat exchanger before returning to the chiller; the other part cools the cutting head.

- A. Check the circulation water lines for damage or blockages caused by animals, pressure, or collisions.
- B. Inspect the water circulation pipes for signs of aging and check all connections for leaks.

The air system has two parts: one provides cutting gases to the cutting head, including clean, dry compressed air, high-purity oxygen, and high-purity nitrogen. The other part supplies auxiliary gases, all clean, dry compressed air, for the air valves and clamping cylinders.



For compressed air, the gas from the compressor passes through a storage tank and a refrigerated dryer before entering the air control cabinet. It then goes through a

precision air treatment system to become clean, dry air, which is divided into two paths: one as cutting gas for the cutting process and the other for cylinder use, powering air valves and clamping the workbench.

- A. Check high-pressure cutting gas lines for signs of aging and ensure there are no leaks at the connections.
- B. Inspect all gas handling components (gas purifiers, check valves, pressure regulators, solenoid valves, etc.) for damage or leaks.
- C. Check high- and low-pressure gas lines for damage or blockages caused by animals, pressure, or collisions.
- D. Inspect auxiliary air circuit components (e.g., roller cylinders, clamping cylinders, exhaust cylinders) for any signs of jamming or damage.

### 3.2 Repair and Maintenance of Lubrication System

The oil lubrication system includes an oil pump and pipelines. Manual lubrication should occur every half month, while the automatic pump operates every 4 hours for 10 seconds. The pump will alarm if the oil level is low, at this time, add standard lubricant. Dust accumulation can block oil lines, affecting lubrication and increasing pump pressure, which shortens pump lifespan. Therefore, regularly clean dust from axes, guides, and racks, and check for oil leaks and pipeline aging.



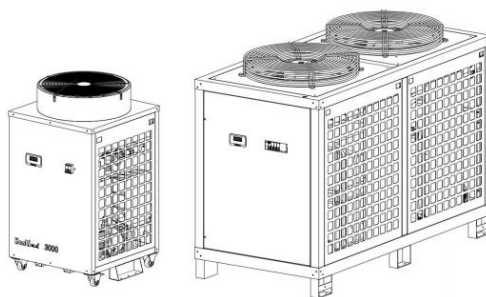
Check that the oil level is correct and add standard lubricant as needed.

Inspect the oil lines for damage or blockages caused by animals, pressure, or collisions, and clean as needed.

Verify the oil pump's operational status and power supply to ensure proper function.

### 3.3 Repair and Maintenance of Water Chiller

For maintenance, first turn off the machine and disconnect the power. Wait 3 minutes before starting work to avoid electric shock. If the environment temperature is below 2°C and the machine is off for an extended period, drain all internal water.



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### 3.3.1 Dust Protection in Summer

In summer, clean the equipment condenser and dust filters approximately every 15 days.

### 3.3.2 Freeze Protection in Winter

When transporting or storing equipment for an extended period, drain the water from the tank using the drain valve and remove any residual water from the pump by loosening the drain plug.

If the nighttime temperature drops below 2°C, it is recommended to either keep the equipment running or add antifreeze, with the freeze point set to 5°C below the ambient temperature. When the average daily temperature exceeds 5°C, replace the antifreeze solution with softened water.

### 3.3.3 Daily Maintenance

In harsh conditions where the chiller operates, to ensure optimal performance and extend its lifespan, maintenance should be performed weekly. This maintenance includes, but is not limited to, the following aspects:

1. Check the cooling medium for contaminants or microbial growth.
2. The cooling medium should be pure water (or distilled water, high-purity water, or deionized water).
3. Replace the cooling medium every 30 days.

### **3.3.4 Inspection and Replacement of Cooling Water**

1. Loosen the hose clamp, remove the water pipe, and move the chiller to a suitable location.
2. Open the drainage valve (located at the bottom of the chiller) to empty the water tank completely.
3. Inspect the tank for debris and floating microorganisms, and clean the interior walls of the tank thoroughly.
4. Close the drainage valve and fill the tank with pure water (or distilled water, high-purity water, or deionized water). Monitor the water level gauge and fill the tank to 85%-95% of its total capacity.
5. Return the chiller to its original position, reconnect the water pipes, and check for leaks. Ensure all valves and pipes are made of stainless steel or high-pressure rubber hose, and galvanized materials are not allowed. Pipe joints should use stainless steel clamps.

### **3.3.5 Inspect External Water Pipes of Laser Source**

Use pressure-resistant PVC pipes with a 6mm inner diameter and 8mm outer diameter or larger (rubber, stainless steel, or copper pipes are also acceptable). For chiller pipes over 10 meters, increase the diameter to maintain the required pressure differential. Pipe specifications may vary by laser source brand and model.

Inspect the external optical path cooling water pipes; PU pipes should have a

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pressure rating of at least 6 kgf/cm<sup>2</sup>. Ensure proper sealing at pipe joints.

Check the filter; it should have a pore diameter of 100 μm, preferably made of transparent plastic. Use filters that meet the manufacturer's specifications between the chiller and the laser source.

Inspect and clean the heat sink and dust filter. Clean by carefully brushing the heat sink, then use compressed air to blow it clean.

Check the condenser and air ducts for any blockages, and regularly remove dust.

Check the water level in the chiller's tank. If low, add purified water (or distilled water, high-purity water, deionized water).

Inspect electrical terminals and remove any dust.

Inspect the water system connections for leaks and check for aging pipes. Replace any components if leaks are detected.

Clean the filter elements every 7-10 days to remove debris. Replace damaged filters promptly, ensuring that replacement filters meet the manufacturer's standards.

Perform regular maintenance on the chiller to ensure optimal performance. If a malfunction occurs, contact a professional technician for repairs; do not attempt to disassemble the machine yourself.

### **3.4 Repair and Maintenance of Electrical Connections**

Inspect the main power circuit breaker and all sub-power and emergency stop circuit

breakers for proper functionality.

Check that the laser cutter power connections are correct, with the workshop's 380VAC supply connected to the main breaker QF0 terminals.

Ensure that the main and sub-power circuit breakers (e.g., for the main unit, laser source, air compressor) meet the specified capacity requirements.

The wire gauge for the power, ground, and neutral lines must meet the specifications. Check that the ground wire is properly connected.

Check that all high-voltage wire terminals, especially the input and output points of the power transformer, are secure and reliable. Ensure that all plugs and sockets are properly connected.

Verify the stability of the power supply voltage, keep the electrical cabinet clean, tidy, and well-ventilated. Inspect the integrity and safety of all wiring.

## **3.5 Inspection and Cleaning of Optical Systems**

### **3.5.1 Precautions**

1. Avoid touching optical lenses (such as protective and focusing lenses) directly, as this can scratch the surface. Clean lenses promptly if they have oil or dust to ensure proper performance.



2. Do not use water or detergents to clean optical lenses, as they can damage the lens coating.
3. Avoid placing lenses in dark, damp areas to prevent surface deterioration.
4. Keep lenses clean. Dust, dirt, or moisture can damage the coating and affect laser quality or prevent laser emission.
5. Replace damaged lenses promptly.
6. When installing or replacing lenses, avoid excessive pressure to prevent deformation and ensure beam quality.

### 3.5.2 Methods to Install or Replace Optical Lenses

1. Before installing optical lenses, wear clean clothing and wash your hands with soap or detergent. Avoid touching the lens surfaces with any part of your hands; handle the lens by its edges, not the coated surfaces.
2. When assembling lenses, do not blow on them. Place the lenses on a clean surface with lens tissue underneath. Handle the lenses carefully to avoid scratches or drops, and never apply pressure to the coated surface. Ensure the lens holder is clean, using an air gun to remove any dust or debris, then gently place the lens into the

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holder.

3. When securing the lens in the holder, avoid using excessive force to prevent deformation, which could affect beam quality.
4. When replacing optical lenses, handle them with care to avoid damage. Do not apply pressure to the lens before removing the packaging. Wear clean gloves when taking reflective lenses and focusing lenses out of their boxes, holding them by the edges. Be cautious when removing the packaging paper to prevent dust from settling on the lens.
5. After removing the lens, use an air gun to blow off any dust on the surface and place the lens on special lens paper. Clean the dust and debris from the lens support and holder, ensuring no foreign particles fall onto the lens during assembly. When mounting the lens in the holder, avoid excessive force to prevent deformation. Once assembled, use the air gun again to remove any remaining dust or particles from the lens.

### 3.5.3 Steps for Cleaning Lenses

#### Steps for Cleaning Lenses with Lens Paper:

1. **Remove Dust:** Use an air blower to blow off any dust from the lens surface.



2. **Apply Cleaning Solution:** Place lens paper flat on the lens surface, apply 2-3 drops of high-purity alcohol or acetone.
3. **Wipe the Lens:** Slowly pull the lens paper horizontally towards you. Repeat this process until the lens is clean.
4. **Handle Stubborn Dirt:** If the lens is very dirty, fold the lens paper 2-3 times and repeat the above steps until clean.

**Important:** Never drag dry lens paper across the lens surface.

#### Steps for Cleaning Lenses with Cotton Swabs:

1. **Remove Dust:** Use an air blower to remove dust from the lens surface.
2. **Remove Debris:** Use a clean cotton swab to gently remove any dirt.
3. **Apply Cleaning Solution:** Dip a new cotton swab in high-purity alcohol or acetone, and clean the lens in a circular motion from the center outward. After each complete circle, switch to a new swab and repeat until clean.



4. **Final Clean:** Use a clean cloth to remove any residue, being careful not to scratch the surface.
5. **Inspect the Lens:** Hold the lens in good lighting to check for cleanliness. If the reflection is clear, the lens is clean; if not, repeat the cleaning process.
6. **Reassemble:** Once clean, place the lens in its mount as described earlier.

**Important:** Never reuse a cotton swab during the cleaning process.

### 3.5.4 Optical Lens Storage

1. Store optical lenses properly to maintain their quality.
2. The storage environment should be between 10-30°C. Do not store lenses in a freezer or similar environment, as condensation can occur when removed, potentially damaging the lens. In addition, the temperature should not exceed 30°C to avoid affecting the lens coating.
3. Store lenses in a box and place them in a vibration-free environment to avoid deformation and maintain performance.

### 3.6 Repair and Maintenance of Laser Source and Optical Path



- A. Regularly maintain the laser source.
- B. Follow the laser source manual for its maintenance.
- C. Check the power cable and ensure the casing of the laser source is properly grounded. Before powering on, use a multimeter to check continuity between the

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laser casing and the ground (PE yellow-green wire). Poor grounding can potentially damage the laser source.

- D. The control lines and voltages for the laser source must meet its technical specifications. Failure to comply can cause irreparable damage. Therefore, before powering on the laser source, ensure that all voltage signals meet the product requirements.
- E. Protect the fiber optic cable and output head from bending or stress. These parts are delicate; handle with care and inspect regularly.
- F. Protect the laser fiber optic output head from dust. If dust is present, clean according to the lens cleaning protocol:
  - 1) Use 99.9% pure ethanol.
  - 2) Use lint-free cotton swabs, avoiding regular cotton swabs that can shed fibers and cause secondary contamination.
- G. **Power on in the following order:**

Start the water chiller (ensure it's working properly and the water temperature is around 25°C).

  - 1) Power on the laser source.
  - 2) Launch the control software.
  - 3) Check the air system.
  - 4) Verify the control system is operational.
  - 5) Prepare the laser for operation.

6) Ensure safety protections are in place.

7) Start the cutting system.

**E. Power off in the following order:**

1) Shut down the equipment control system.

2) Turn off the laser control signal.

3) Power off the laser source.

4) Stop the water chiller.

F. Other notes: During laser source operation, ensure that the water, air, and electrical systems are functioning properly. If any issues arise, power off and investigate the cause.

G. If any faults occur during laser operation, record the time, symptoms, and system status at that time. Troubleshoot the issue and contact us if you have any questions

H. For prolonged use of the laser source, clean the cooling water lines, keep the laser source clean, and regularly replace the cooling water in the chiller.

### 3.7 Repair and Maintenance of Air Compressor



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## 3.7.1 Daily Maintenance

1. Record the machine's operating status daily.
2. Clean the air filter dust bag and intake silencer chamber. Do not operate the machine without the air filter. If the air filter differential pressure switch triggers an alarm, maintain the filter.
3. Check if the oil level is within the specified range.
4. When the smart controller alarms due to a clogged oil filter, please replace the oil filter.

## 3.7.2 Weekly Maintenance

1. Check if the safety valve is blocked or damaged.
2. Inspect the oil filter after the first 50 hours of operation for a new machine and replace the filter element if necessary.
3. Clean the orifice and filter screen (if equipped) on the secondary oil return line after the first 50 hours of operation for a new machine.

## 3.7.3 Quarterly Maintenance

- A. Remove dust from the machine's air intake.
- B. Remove the air filter and inspect the filter element; perform maintenance on the filter element as needed.
- C. Remove the intake piping, clean it, and allow it to dry.

- D. Replace the oil filter during initial use.
- E. Replace the lubricating oil during initial use.
- F. Check the belt tension and adjust if necessary.
- G. Inspect and clean the orifice and filter screen (if equipped) on the secondary oil return line.

### 3.7.4 Annual Maintenance

- A. Replace the air filter element.
- B. Inspect the spring valve plate inside the check valve to ensure it functions correctly; replace if necessary.
- C. Replace the lubricating oil.
- D. Check and calibrate the pressure gauge and sensors.
- E. Inspect the capacity adjustment (loading) solenoid valve (a 2-position, 3-way normally closed solenoid valve); replace the internal seals if necessary.
- F. Review the machine's operating condition records to determine if the cooler needs cleaning. If so, it's best to use a chemical reagent to clean the interior of the cooler.
- G. Replace the oil filter;
- H. Replace the oil-gas separation core.

### 3.7.5 Preparation for Long-term Shutdown of Air Compressor

If the interval between shutdown and restart is relatively long, before shutting down,

manually open the (electronic) drain valve to allow it to drain for at least 5 minutes to ensure that all water in the system is expelled. After shutdown, drain any accumulated water from components such as the oil and gas separator and the air receiver tank.

A. If the shutdown period is less than one month, perform the following actions:

- 1) Start the machine once a week and let it run unloaded for 10 minutes.
- 2) Manually turn the coupling once a week.

B. If the shutdown period exceeds one month, perform the following actions:

#### **Preparation for Shutdown:**

- 1) Run the machine under load for 10 minutes to expel air from the pipelines.
- 2) After shutdown, manually turn the coupling.
- 3) Drain any accumulated water from components such as the cooler and the air receiver tank.

#### **During Shutdown:**

- 1) Repeat the steps in (A) every three months.

#### **Before Restarting:**

- 1) Replace the lubricating oil in the oil tank, and lubricate the filter, and the oil-gas separation element.
- 2) Manually rotate the connecting components (coupling, belt) between the motor and the main unit to ensure they turn easily.

## 3.8 Repair and Maintenance of Cold Dryer



- A. The ambient temperature for the dryer should not drop below 10°C to prevent refrigerant oil condensation and potential compressor damage.
- B. Check that the dryer's inlet temperature does not exceed the rated value and inspect the control panel indicators daily.
- C. Check the automatic drain daily to prevent clogging. If clogged, close the ball valve in front of the solenoid valve and clean the solenoid valve.
- D. Inspect the fin surface of the air-cooled condenser monthly for scaling and clean it regularly.
- E. Listen to assess if the compressor runs smoothly and check for any unusual noises.
- F. The air bypass valve should remain fully closed during normal operation.
- G. Check all electrical connections for looseness monthly.

## 4 Maintenance during Long-term Downtime

When storing the machine long-term, grease all moving parts and wrap them in anti-rust paper. Regularly check for rust on other parts and treat as needed. If possible, use a dust cover on the equipment. In addition, clean and inspect the machine regularly.

### 4.1 Maintenance of Water Chiller in Winter

To protect your laser equipment in winter:

- A. Install air conditioning or heating to maintain the ambient temperature around 10°C.
- B. Run the chiller 24 hours a day to prevent water from freezing while it's in motion.  
(Ensure the power supply is continuous.)
- C. Add antifreeze glycol to the water chiller to prevent freezing. The freezing point changes with the concentration of glycol in the solution.

Comparison of Ethylene Glycol Antifreeze Concentration and Freezing Point	
Ethylene glycol content (%)	Freezing point (°C)
26	-10
32	-15
37	-20
40	-25
45	-30
50	-35

- D. We recommend using Clariant Antifrogen N antifreeze with a mixing ratio of 3:7 (3 parts antifreeze to 7 parts water). This mixture can resist freezing down to -20°C.



- E. If the ambient temperature around the laser source is between 10°C and 40°C, no antifreeze is needed. In summer, drain the antifreeze from the chiller and refill it with distilled water.
- F. Check the water condition before starting up.
- G. When the equipment is not in use for an extended period or during a power outage,

be sure to drain the water from both the chiller tank and the laser source. (For holiday shutdowns, ensure proper antifreeze and drainage procedures are followed.)

## 4.2 Drainage Method

- A. Turn off the equipment, open the drain valve at the back of the chiller, and empty the water from the tank.
- B. Remove the filter element from the chiller, drain the water from it, and unscrew the drain screw below the pump to empty the water from the pump.
- C. Remove the water pipe from the back of the tank and label it. Use 0.2 MPa (2 kg) of air pressure to blow out the water from the laser source through the pipe ( $\phi 12$ ) (for low-temperature areas).
- D. Use 0.2 MPa (2 kg) of air pressure to blow out the water from the fiber optic head through the pipe ( $\phi 8$ ).

**Note: Too much air pressure can damage the laser source, and high antifreeze concentration can increase circulation resistance.**

**Reminder: Customers are responsible for any damage and repair costs if antifreeze procedures are not followed. Please ensure timely antifreeze measures!**

## **5 Equipment Maintenance Management System**

### **5.1 Purpose**

To ensure the equipment remains in good condition and meets production requirements, keep it orderly, clean, lubricated, and safe.

### **5.2 Maintenance Coverage**

Suitable for the maintenance of fiber laser tube cutting machines.

### **5.3 Requirement**

#### **5.3.1 First Level Maintenance**

Operators must perform daily equipment inspections (using the maintenance checklist) before their shift and record the findings. During the shift, operate the equipment strictly according to the procedures and address any issues promptly. After the shift, clean and wipe down the equipment, and record any abnormalities.

Simple adjustments should be handled by the operator; for more complex issues, report them promptly and contact our company for repair.

#### **5.3.2 Second Level Maintenance**

Thoroughly wipe down and inspect the equipment's exterior and each unit, with special attention to lubrication and oil levels. Completely clean the area around the

equipment.

## 6 Equipment Repair Management System

### 6.1 Purpose

To expedite repairs, fully document equipment faults and analyze their causes.

### 6.2 Repair Scope

Suitable for the maintenance of fiber laser tube cutting machines.

### 6.3 Requirement

If a fault occurs, stop production, fill out a repair request, and report it to maintenance.

Maintenance staff will address the issue on-site.

They can contact us for online support, or request on-site assistance from our service engineers if needed.

★ **To keep your equipment in good condition, follow the maintenance guidelines in this manual.**

## Appendix 1 Contact Us

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